AGU FALL MEETING
San Francisco | 15–19 December 2014

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P53C-4020 Exploring the Inner Edge of the Habitable Zone in the Early Solar System

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3-D models can help explore the possible roles of rotation, atmosphere and ocean dynamical transports, cloud feedbacks and sea ice-albedo feedbacks in determining the habitability of a range of planetary environments. Using recent modifications to the Goddard Institute for Space Studies (GISS) IPCC AR5 General Circulation Model (GCM) we have explored the Inner Edge of the habitable zone (HZ) of our Solar System. We find that while Venus is currently outside the HZ, it may have been close to or within it early in Solar System history when the solar luminosity was lower and an ocean may have been present.
The GISS GCM maintains habitable equilibrium surface temperatures for a solar constant 40% stronger than present day Earth (comparable to the Faint Young Sun at Venus' orbit) even if Venus rotated as rapidly as Earth early in its history. Stratospheric water vapor concentration is an order of magnitude smaller than the classical water loss limit for this simulation. We have also explored the parameter space in models with slower rotation rates. Our results are based on an atmosphere coupled to two different Earth ocean models, one a 100m mixed layer ocean with no ocean heat transport, and a second with a fully coupled dynamic ocean. Negative cloud feedbacks due to increasing high, thick clouds in the tropics as the planet warms appear to be the stabilizing mechanism, along with maintenance of subsaturated water vapor by the general circulation.

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